Analysis of propulsion power data of Ro-Ro ships and analysis of the CEN standard 16258 for Ro-Ro ships

by

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Speed and power for Ro-Ro ships

Introduction

This report contains the results of test calculations carried out with two versions of the so-called SHIP-DESMO model for 1) Ro-Ro cargo ships and 2) Ro-Ro passenger ships. The theoretical background for these two SHIP-DESMO models is described in three separate reports:

1. Report No. 1: *"Prediction of resistance and propulsion power of Ro-Ro ships"* by Hans Otto Kristensen

2. Report No. 2: *"Analysis of technical data of Ro-Ro ships"* by Hans Otto Kristensen

3. Report No. 3: *"Energy demand and exhaust gas emissions of marine engines*" by Hans Otto Kristensen

All three reports have been prepared as deliverables for the project no. 2014-122: Mitigating and reversing the side-effects of environmental legislation on Ro-Ro shipping in Northern Europe. Work Package 2.3 carried out for The Traffic Section of The Technical University of Denmark.

In Report No. 1 it is shown that propulsion power determined by using an empirical method (based on ship resistance calculated using the so-called Guldhammer and Harvald: "Ship Resistance" method) yields results which are very close to actual results obtained from model tests with Ro-Ro ships.

Furthermore extensive technical data for Ro-Ro ships have been analyzed and described in Report No. 2, such that two generic ship design and power prediction models for Ro-Ro cargo and Ro-Ro passenger ships have been developed for this project. Results of calculation of the main engine power with these models are presented in this report where the power has been compared with the actual main engine power for a large number of Ro-Ro ships from the so-called Ship-Pax database.

Service speed for Ro-Ro cargo ships

The service speed is given in the ShipPax data base and in Significant Ships (1990 – 2014). The service speed for Ro-Ro cargo ships is plotted as function of lane meters in Fig. A1 in Appendix A. Comparing the service speed in the ShipPax database with the speed in Significant Ships it seems quite evident that the speed in Significant Ships is also the service speed. Based on Fig. A1 following equation has been obtained for determination of the service speed for Ro-Ro cargo ships:

$$\text{Service speed} = 5.04 \cdot \text{lanemeter}^{0.173}$$

The variation of the service speed is very roughly plus/minus 20 % as shown in Fig. A2 in Appendix A. Test calculations using the normal speed but also using a service speed reduced and increased by 20 % respectively are shown in Fig. A3, where it is seen that the resulting engine power calculated by the SHIP-DESMO model is within the complete statistical engine data for all Ro-Ro cargo ships in the ShipPax data base.

Furthermore the Ro-Ro cargo ships in the Ro-Ro ShipPax database have been sorted such that the ships where the service speed varies within plus/minus 5 % from the normal/average speed have been analyzed separately and compared with results from the SHIP-DESMO model using the normal speed. The results of this separate comparison are shown in Fig. A4 in Appendix A. It is seen that the predicted engine power is on the same level as the engine power from the statistical sample of Ro-Ro cargo ships from the ShipPax database with “normal speed”.

Service speed for Ro-Ro passenger ships

The service speed for Ro-Ro passenger ships is plotted as function of Lpp in Fig. A5 and A7 in Appendix A. Comparing the service speed in the ShipPax database with the speed in Significant Ships it seems quite evident that the speed in Significant Ships is also the service speed. From Fig. A5 and A7 following equations have been obtained for determination of the service speed for Ro-Ro passenger ships:

Low cargo density ships: Service speed = $0.085 \cdot Lpp + 8.98$

High cargo density ships: Service speed = $0.0695 \cdot Lpp + 10.16$

The variation of the service speed is very roughly plus/minus 15 % as shown in Fig. A6 and A8 in Appendix A. Test calculations using the normal speed but also using a service speed reduced and increased by 15 % respectively are shown in Fig. A9, where it is seen that the resulting engine power is within the complete statistical engine data for all Ro-Ro passenger ships in the ShipPax data base.

Furthermore the Ro-Ro passenger ships in the Ro-Ro ShipPax database have been sorted such that the ships where the service speed varies within plus/minus 5 % from the normal/average speed have been analyzed separately and compared with results from the SHIP-DESMO model using the normal speed. The results of this separate comparison are shown in Fig. A10 in Appendix A. It is seen that the predicted engine power is on the same level as the engine power from the statistical sample of Ro-Ro cargo ships from the ShipPax data base with “normal speed”.

From the different comparisons of predicted engine power using the two SHIP-DESMO models and the statistical engine data for similar ships in the ShipPax database it can be concluded that the two SHIP-DESMO models give results, i.e. main engine power, which are on the level as real main engine powers levels from existing Ro-Ro ships.

Implementation of the CEN Standard 16258 in the SHIP-DESMO model for Ro-Ro passenger ships

Transport services carried out by Ro-Ro passenger ships fulfils two separate transport needs, namely 1) passenger related transport of passengers and personal cars, campers etc. and 2) pure freight transport of trucks and other rolling cargo such as unaccompanied vehicles/mafi trailers.

The CEN Standard 16258 describes two different allocation methods for allocation of the total ship emissions on passenger and freight transport. The two methods are the so-called 1) mass method and the 2) area method.

Mass method

Calculation of the mass shall be based on:

- Number/mass of passengers
- Number/mass of accompanied cars
- Number of accompanied caravans and mobile homes etc.
- Number/mass of accompanied busses
- Total mass of cargo being carried, including any packaging, container, and means of handling or means of transport like trailers and vehicles

Area method

The area method is based on 100 % accessible area capacity according to valid general arrangement plan including following areas:

- Accessible vehicle deck area, including hanging decks (if available and operational)
- Accessible passenger deck area

Area not in use for passenger and cargo, such as bridge, engine area, crew area, galley and other service areas are excluded.

Default values for mass, length and width presented in Table 1 may be used for both methods.

Table 1 Default values for mass, length and width

	Mass (kg)	**Length (m)**	**Width (m)**
Passenger and luggage	100	Not applicable	Not applicable
Passenger car	1500	6	3.1
Bus	15000	12	3.1
Caravan (small)	1000	3	3.1
Caravan (medium)	2000	6	3.1
Caravan (large)	2500	10	3.1
Mobile home	3500	8	3.1
Motorcycle	200	1.5	3.1
Unaccompanied trailer	8000	14	3.1
Accompanied/articulated trailer	16000	17	3.1
Road train - Continent	18500	19	3.1
Road train - Scandinavia	20000	24.5	3.1

In the CEN Standard 16258 guideline it is mentioned that the above mentioned masses and associated areas may be used in the calculations. However for passenger cars and lane meters for rolling cargo more correct values are obtained from a paper especially on the issue of space allocation [Kristensen and Hagemeister 2011]. Based on this reference following the areas in Table 2 have been found as representative for 60 Ro-Ro passenger ships. Figures showing the statistical analysis of the data for different types of area are given in Appendix B.

Table 2: Area for Ro-Ro deck space and accommodation for Ro-Ro cargo ships

Unit	General	Low comfort	High comfort
m^2 per lane metre	4.1	-	-
m^2 per car	15.0	-	-
m^2 per unberthed passenger (area for cafeteria, restaurants, halls and corridors and toilets, i.e. passenger related accommodation)	2.4	1.8	3.0
m^2 per berthed passenger (cabin area)	4.5	-	-

Using the areas in the Table 1 and 2 the CEN Standard 16258 calculation procedures have been implemented in the SHIP-DESMO model for Ro-Ro passenger ships using the calculation example shown in Appendix C for the CEN standard.

Calculation examples from SHIP-DESMO

In Appendix D are shown some calculation examples from SHIP-DESMO with different cargo and passenger mixtures.

In the first 3 examples, No. 1 – 3, the ship (With a maximum capacity of 1000 passengers) is 100 % loaded with trucks but with different number of passengers as follows: 650 passengers (Example No. 1), one (1) passenger (Example No. 2) and finally NO passengers (Example No. 3). The results of the area allocation principle are shown in the output from the three example calculations in Appendix D. It is seen that because the ship does not carry any passenger cars only the total area of the passenger accommodation is taken into account in the allocation calculation for passengers - irrespectively of the numbers of passengers, according to the principles in the CEN Standard 16258 calculation example in Appendix C.

The result of using this principle is that 35 % of the emissions are to be allocated to 650 passengers in Example No. 1, to only one passenger in Example 2, while it cannot be allocated to any passengers in Example 3, as NO passengers are carried in this example. In all the cases 65 % of the emissions are to be allocated to 2362 lane meters of trucks, also in Example 3, where all the ships emissions rightly should be allocated to the trucks as no passengers are carried. However due to the passenger area allocation principles 35 % of the total emissions are indirectly excluded from the allocation calculations, which is a fault in the CEN Standard example in Appendix C.

However if the complete passenger area is weighted by the number of passengers in per cent of the total number of passengers more reasonable results are obtained using the area allocation principles as can be seen in Example 4 – 6 in Appendix D, which are revised versions of Example 1 – 3, where the passenger area used for the area based emission allocation has been weighted according to the actual number of passengers on board. In Example No. 6 with NO passengers, all emissions are allocated on the trucks, which is definitely the most correct way to carry out the calculations.

Example No. 7 – 9 in Appendix D are identical with Example No. 4 – 6, however in such a way that the emission allocation is done by using the mass method. Comparing the examples reveals relatively large differences in these more extremes loading cases, where the only vehicles on the

car decks are trucks. Many pros et cons can be listed for both allocation principles, as it is a well-known fact that passengers impose a lot of extra lightweight due to the passenger accommodation. On the other hand when a Ro-Ro ship carries very much rolling cargo it is also natural to allocate the emissions mostly on this rolling cargo which the mass method is more focused on. A good compromise to solve the allocation problem might be to use an allocation based on the mean value of the area and the mass allocation factors and such a compromise is also included in the developed SHIP-DESMO model.

References

- Kristensen H. O: *Prediction of resistance and propulsion power of Ro-Ro ships*. August 2015. Report No. 01 of project No. 2014-122: Mitigating and reversing the side-effects of environmental legislation on Ro-Ro shipping in Northern Europe.

- Kristensen H. O: *Analysis of technical data of Ro-Ro ships.* September 2015. Report No. 02 of project No. 2014-122: Mitigating and reversing the side-effects of environmental legislation on Ro-Ro shipping in Northern Europe.

- *Significant Ships 1990 – 2014,* published annually by Royal Institution of Naval Architects (RINA)

- Kristensen H. O and Hagemeister C: *Environmental Performance Evaluation of Ro-Ro Passenger Ferry Transportation*. August 2011. Trafikdage på Aalborg Universitet. ISSN 1603 9696.

- CEN Standard 16258: Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers).

Appendix A – Service speed and main engine power

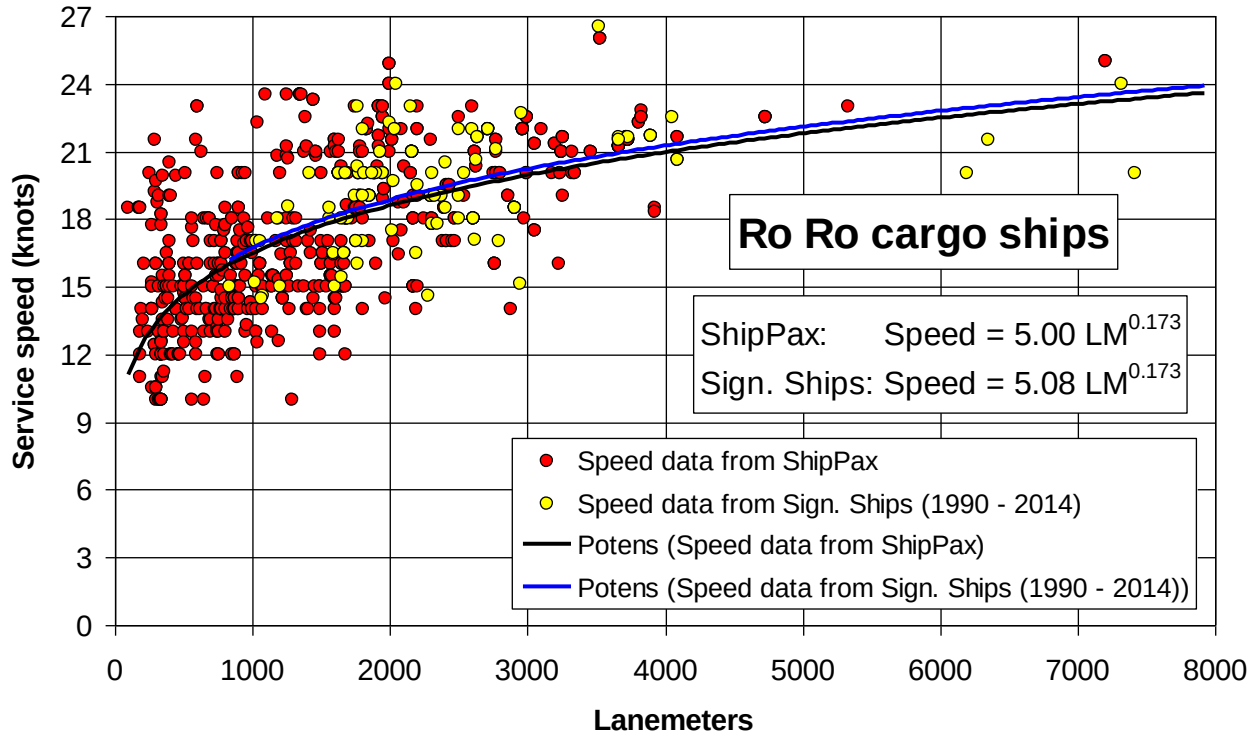

Fig. A1 Service speed for Ro-Ro cargo ships according to ShipPax database and Significant Ships (1990 – 2014)

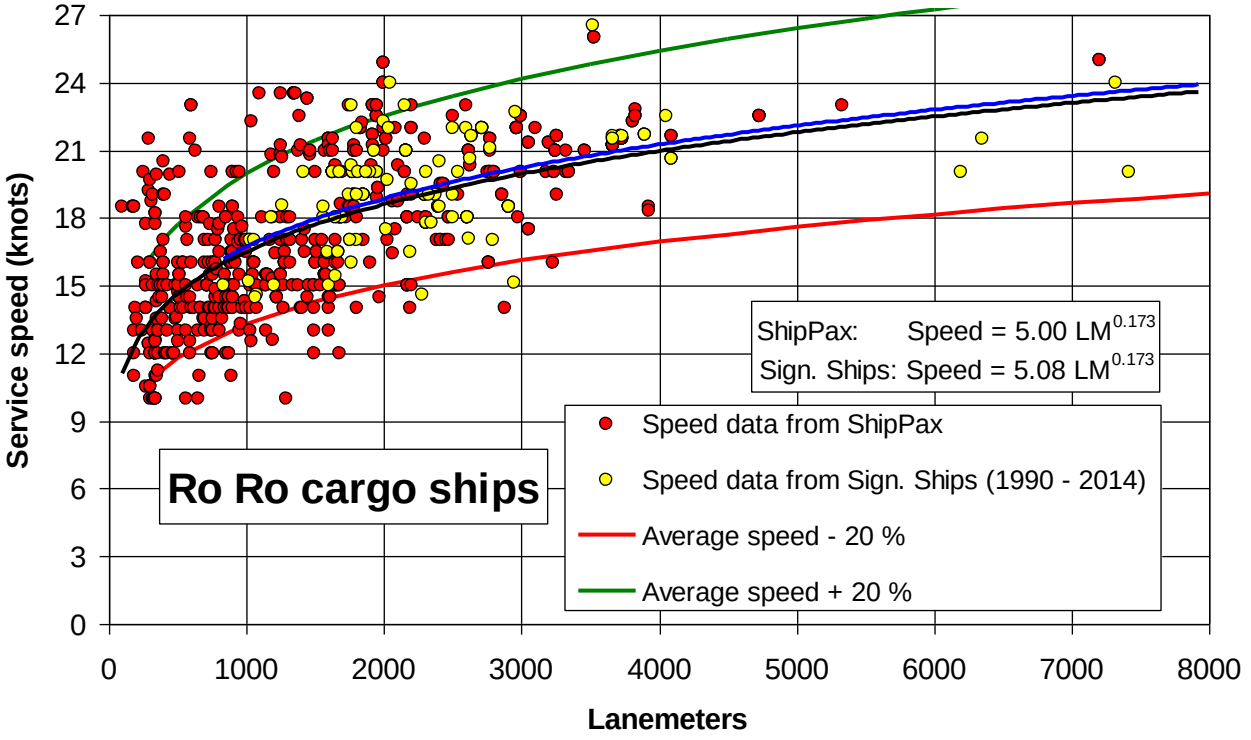

Fig. A2 Service speed for Ro-Ro cargo ships including speed variation in per cent according to ShipPax database and Significant Ships (1990 – 2014)

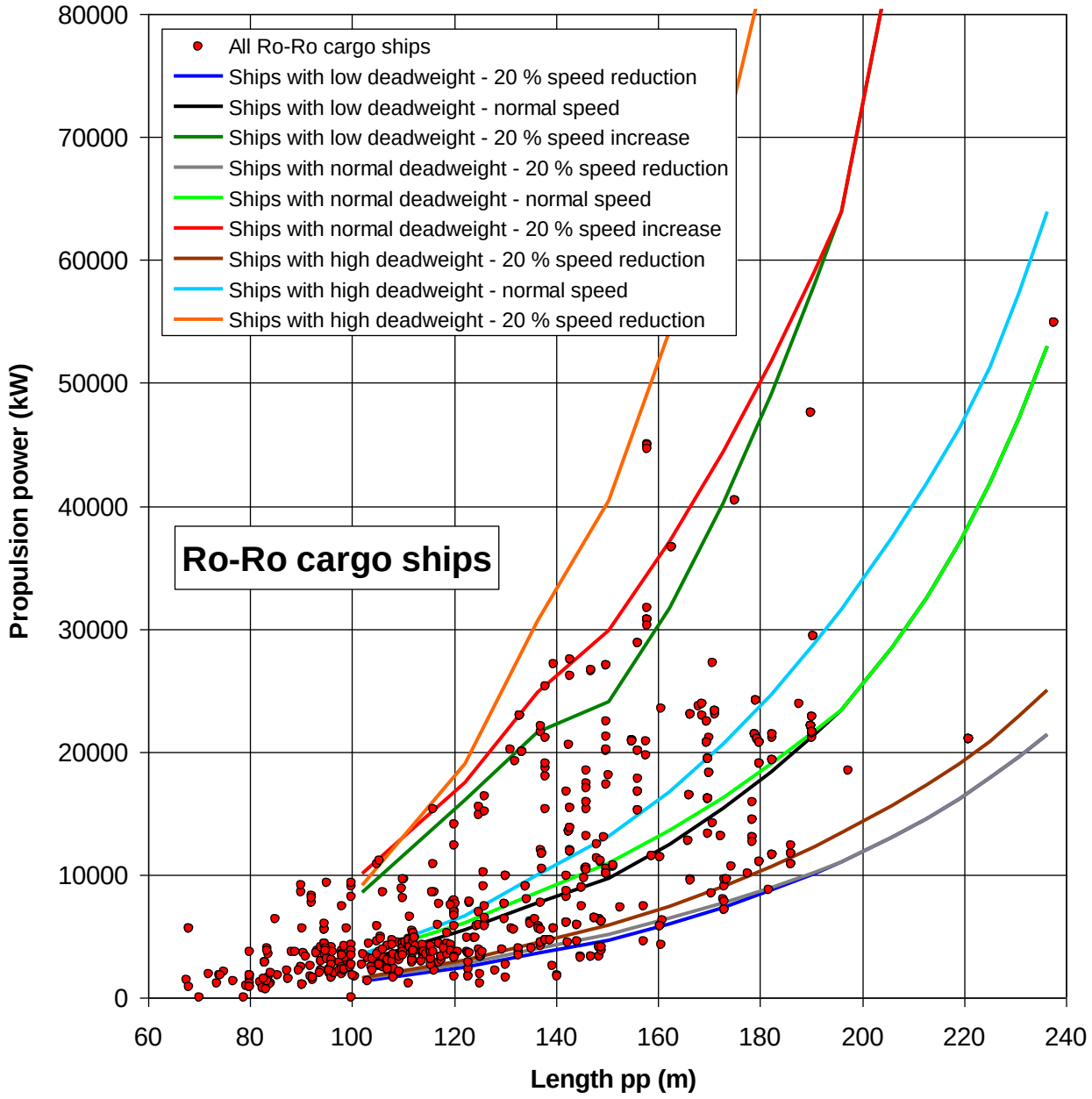

Fig. A3 The main engine power for all Ro-Ro cargo ships in the whole speed range (ShipPax database)

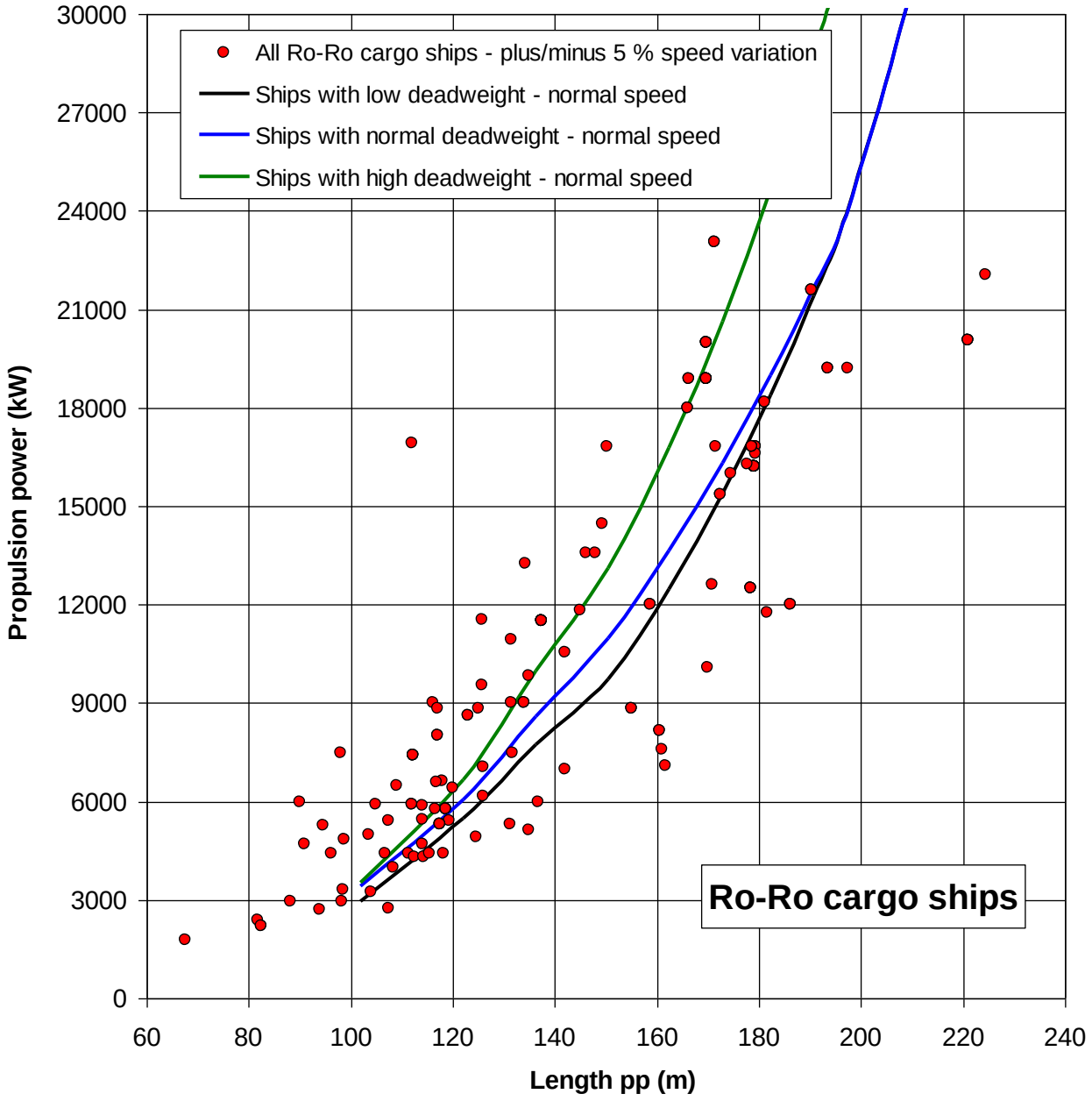

Fig. A4 The main engine power for Ro-Ro cargo ships in the speed range within plus/minus 5 per cent from the average speed given in Fig. A1. (ShipPax database)

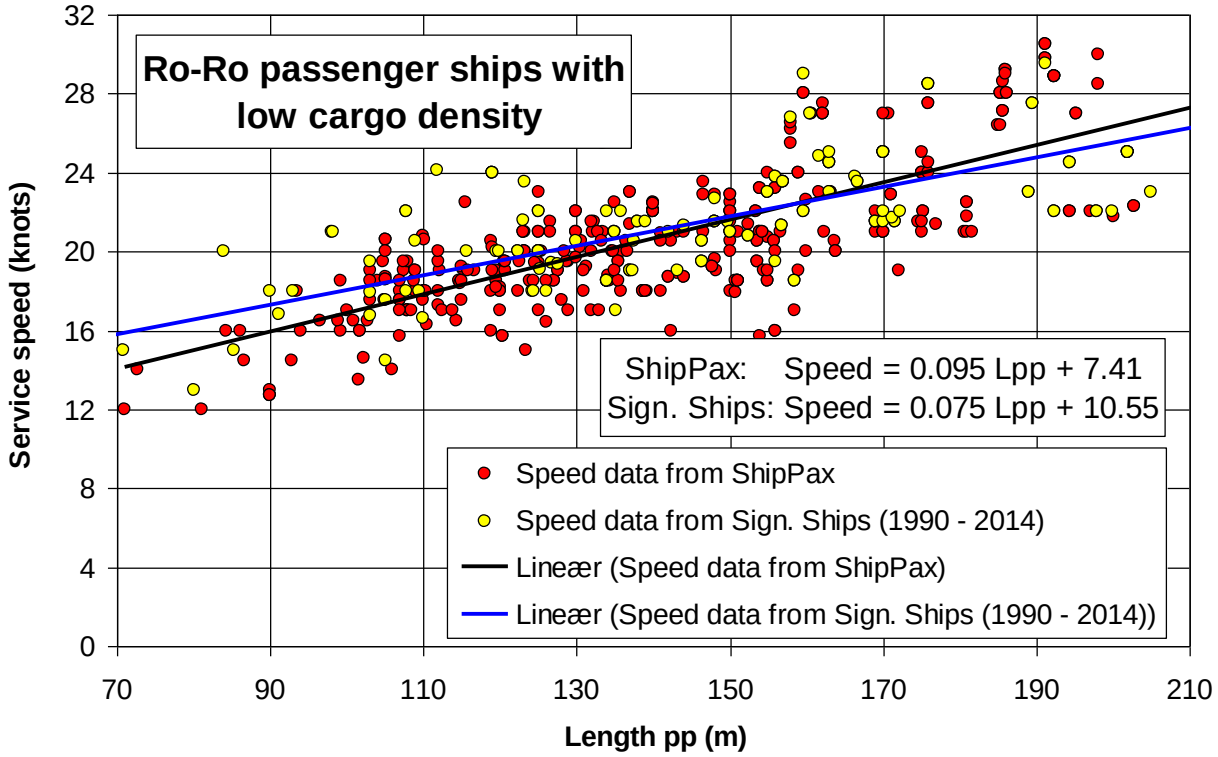

Fig. A5 Service speed for Ro-Ro passenger ships with low cargo density (ShipPax database and Sign. Ships (1990 – 2014)).

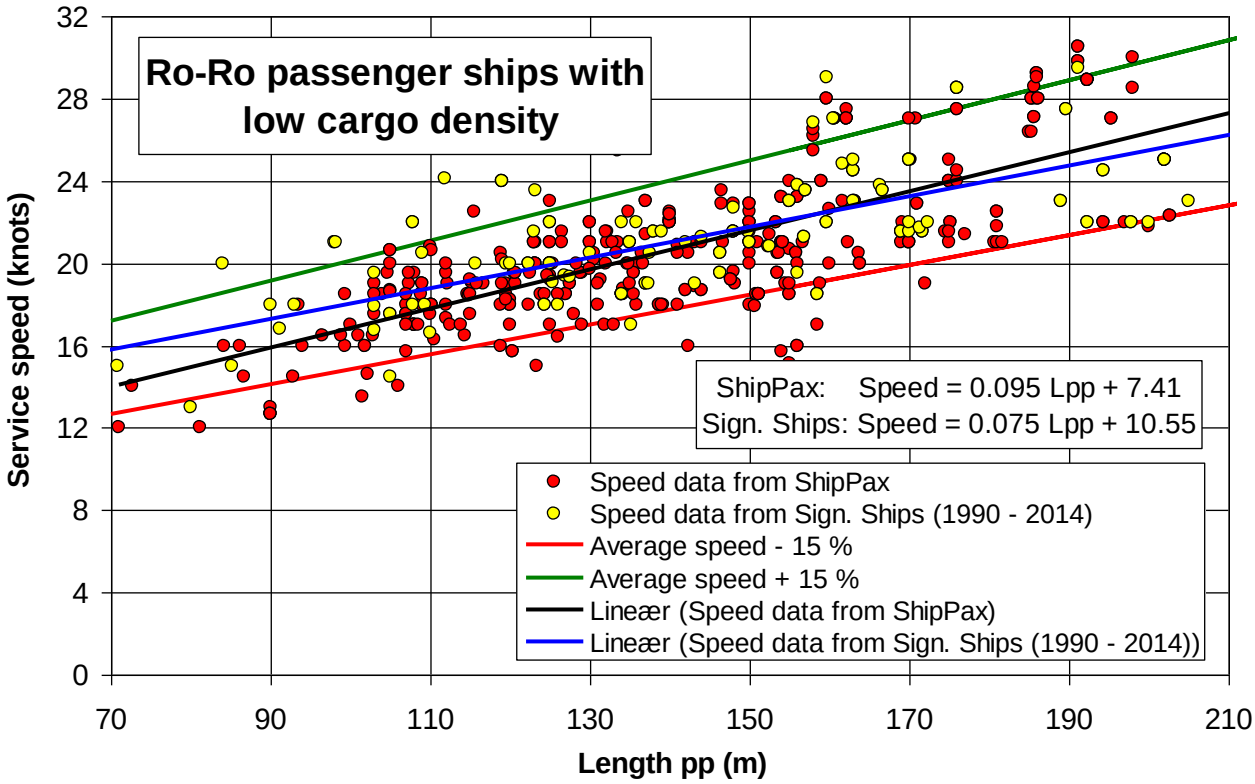

Fig. A6 Service speed for Ro-Ro passenger ships with low cargo density including speed variation in per cent. (ShipPax database and Sign. Ships (1990 – 2014)).

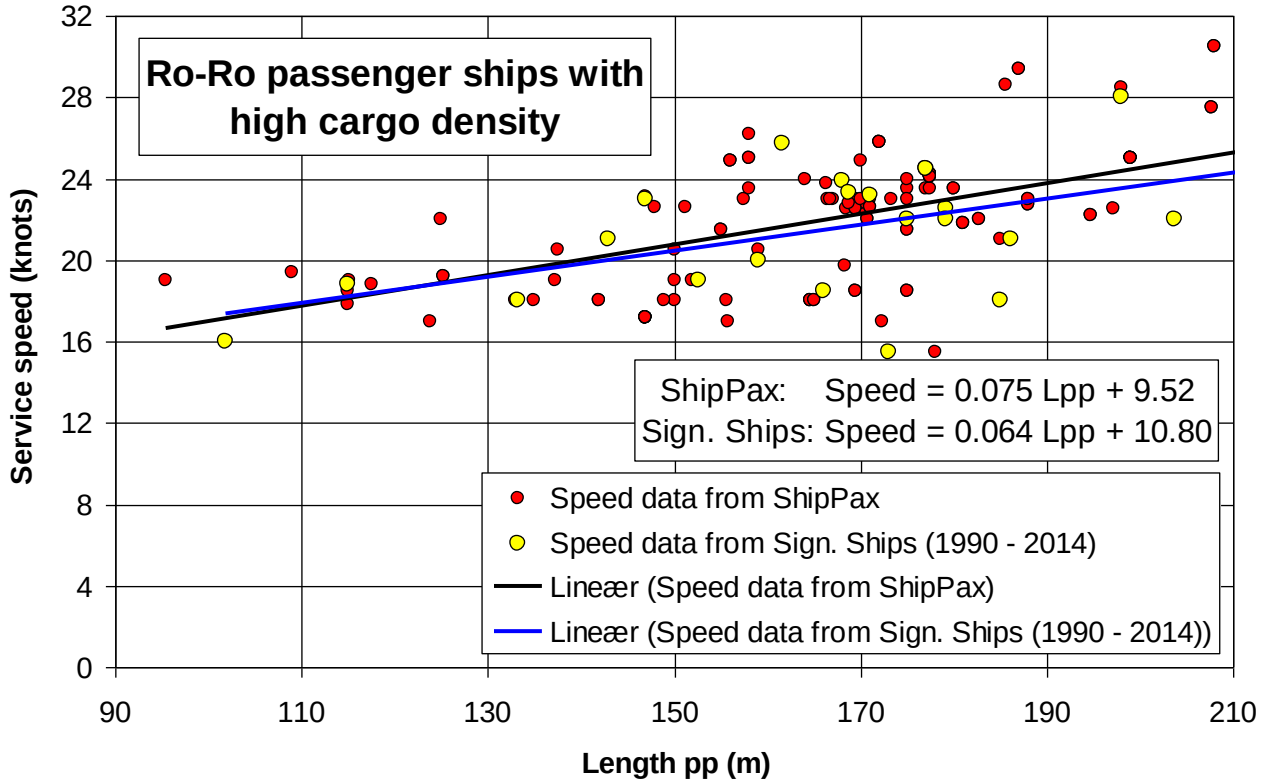

Fig. A7 Service speed for Ro-Ro passenger ships with high cargo density (ShipPax database and Sign. Ships (1990 – 2014)).

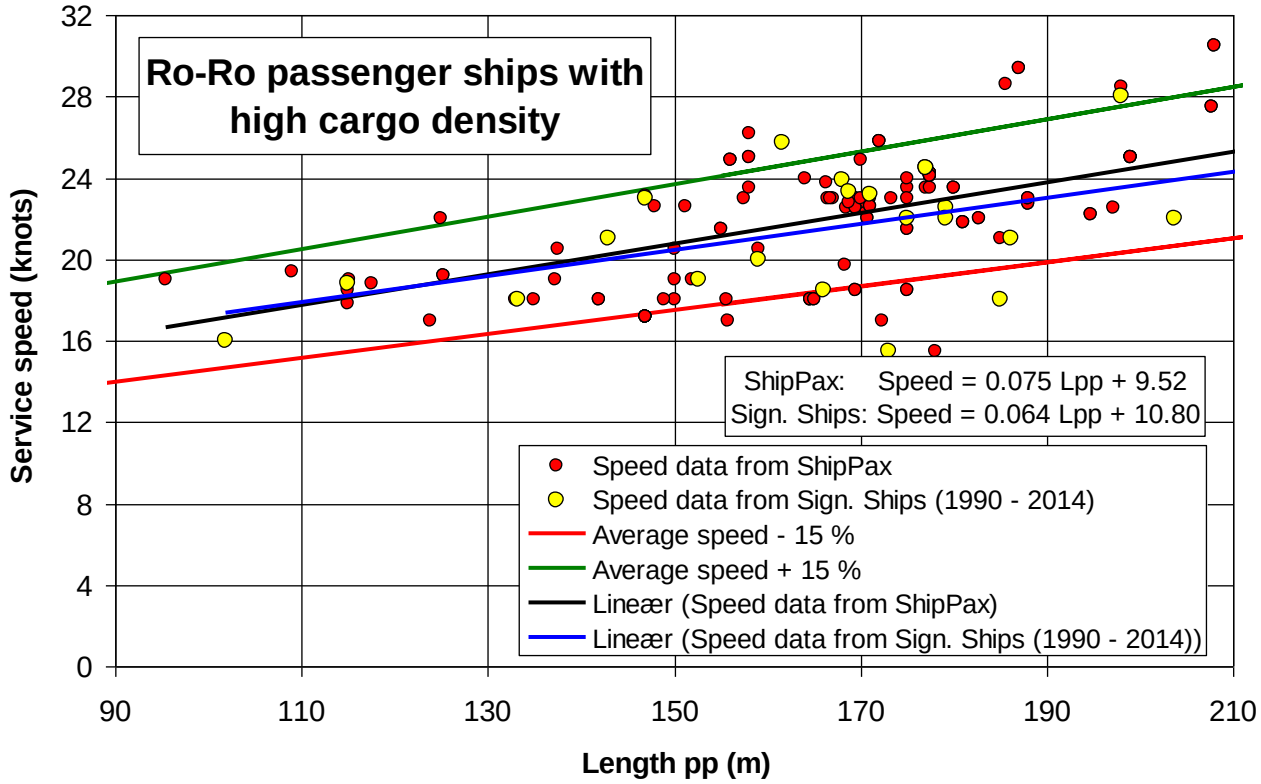

Fig. A8 Service speed for Ro-Ro passenger ships with high cargo density including speed variation in per cent. (ShipPax database and Sign. Ships (1990 – 2014)).

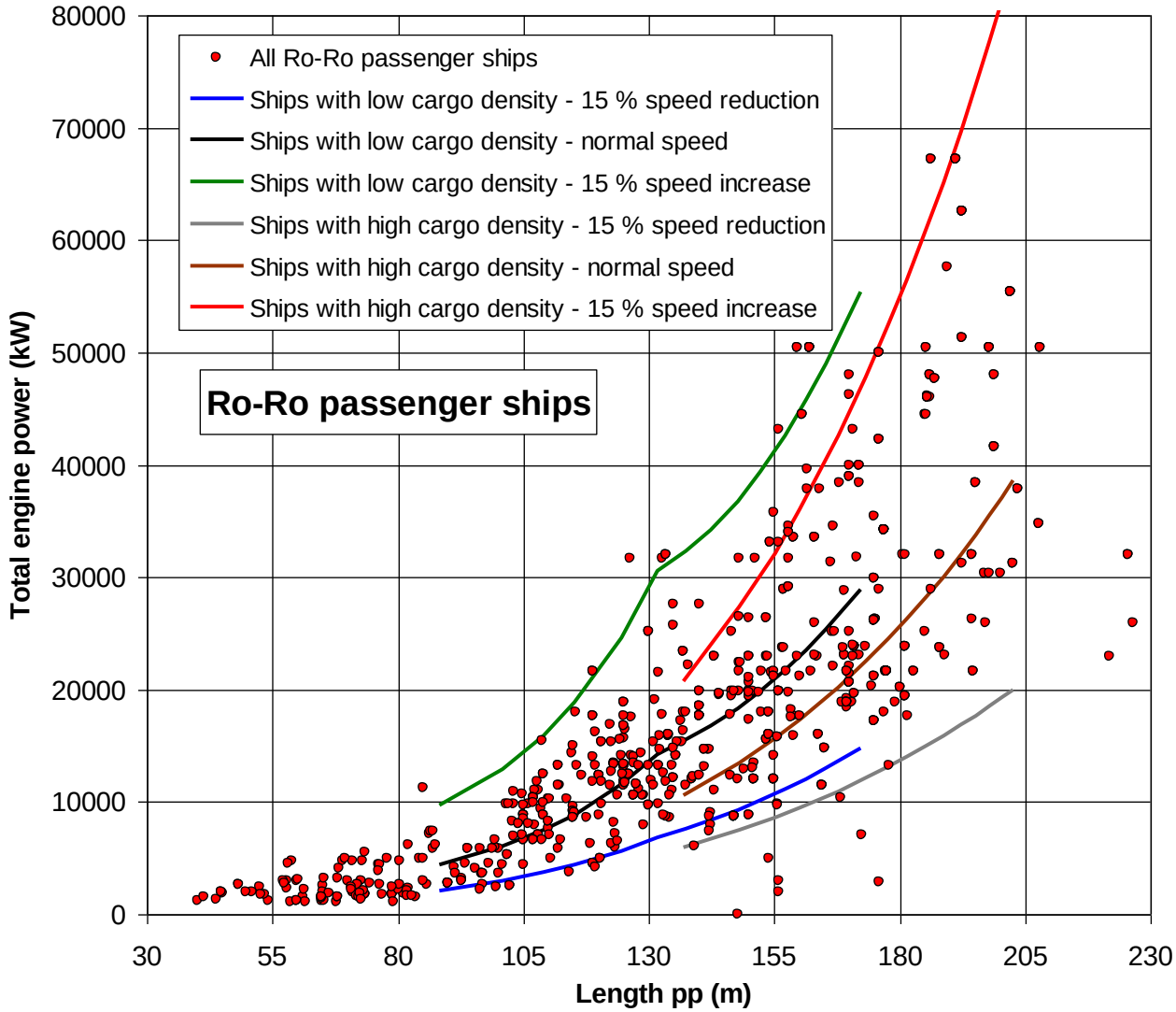

Fig. A9 The main engine power for all Ro-Ro passenger ships in the whole speed range (ShipPax database)

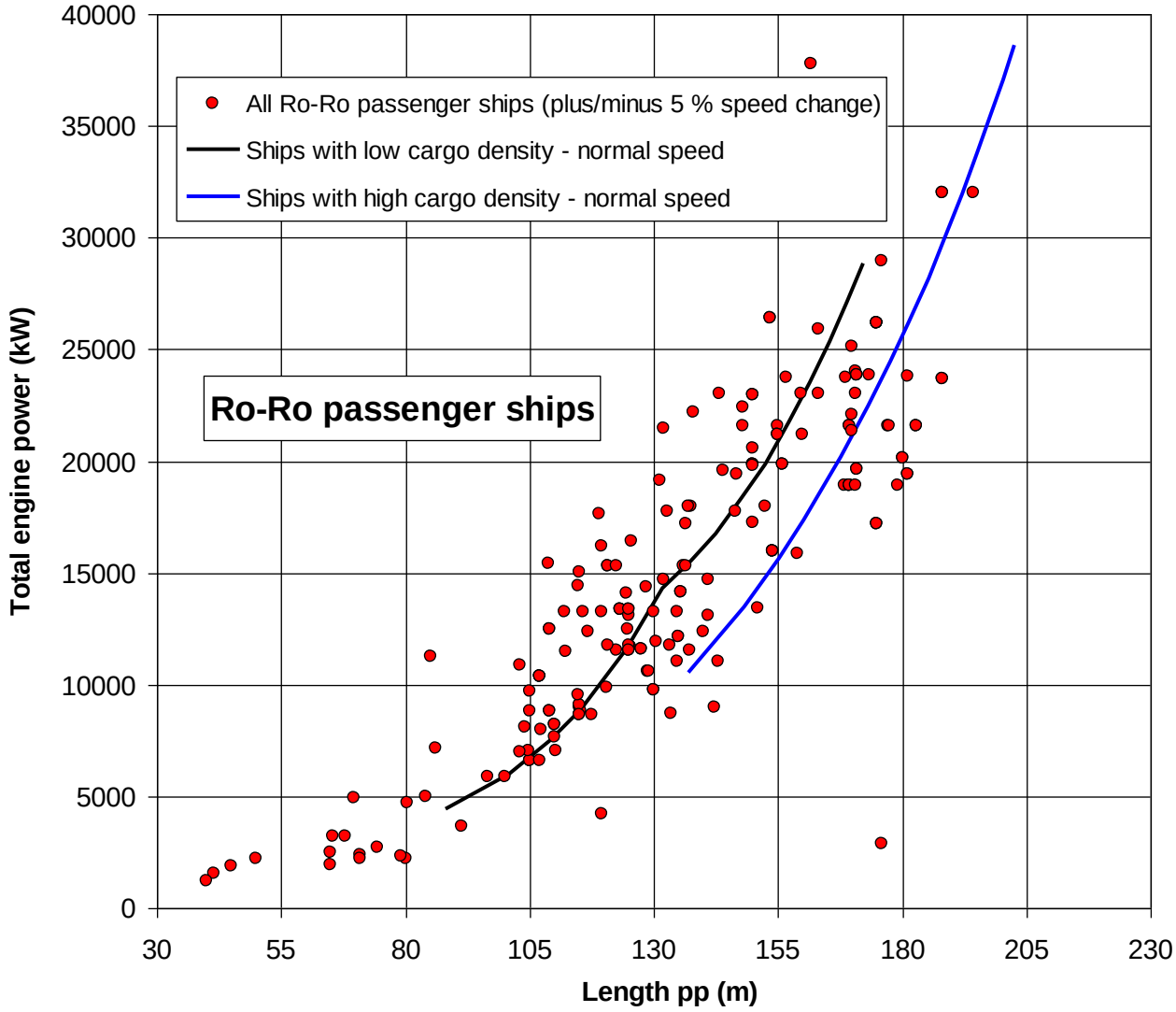

Fig. A10 The main engine power for Ro-Ro passenger ships in the speed range within plus/minus 5 per cent from the average speed given in Fig. A5 and A7. (ShipPax database)

Appendix B - Different interior areas of Ro-Ro passenger ships

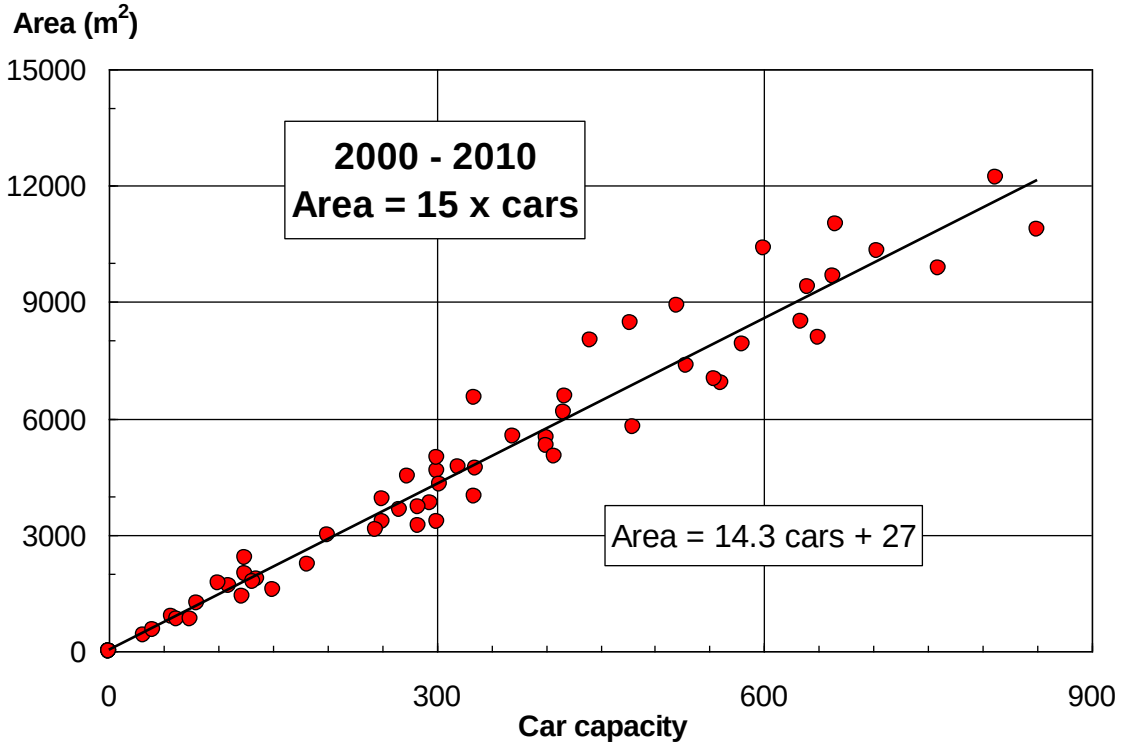

Fig. B1 Car deck area of Ro-Ro passenger ships (Hagemeister thesis work 2011)

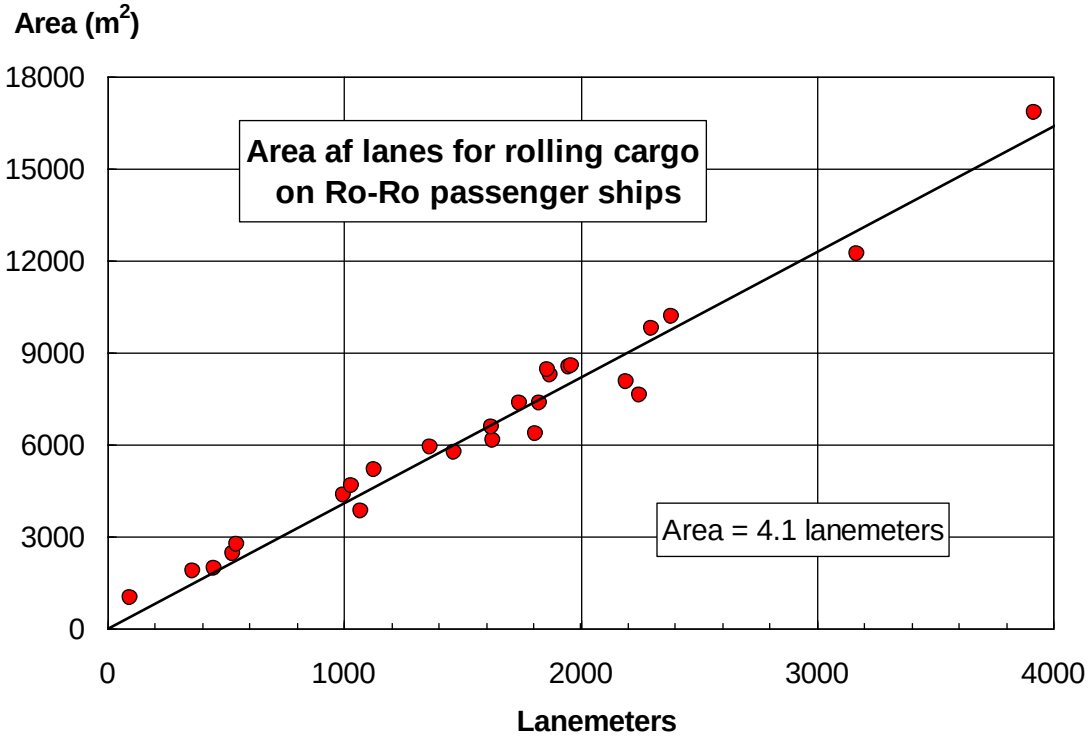

Fig. B2 Area of cargo lanes of Ro-Ro passenger ships (Hagemeister thesis work 2011)

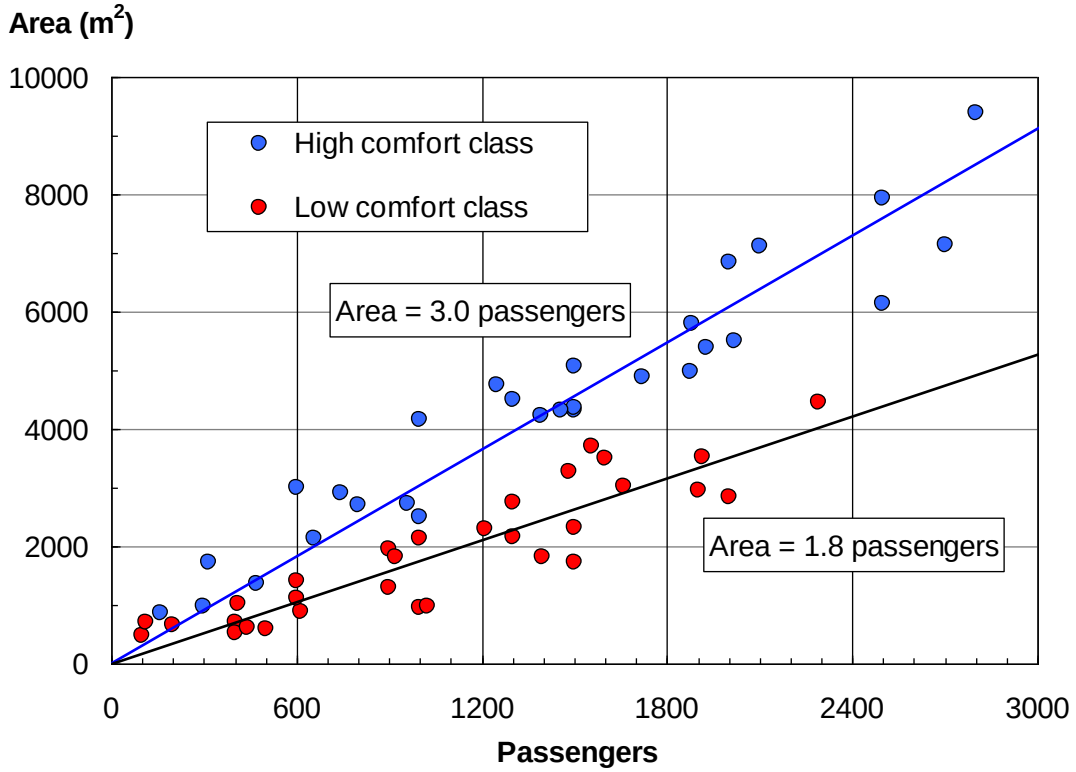

Fig. B3 Area of cafeteria, restaurants, halls, corridors and toilets (Hagemeister thesis work 2011)

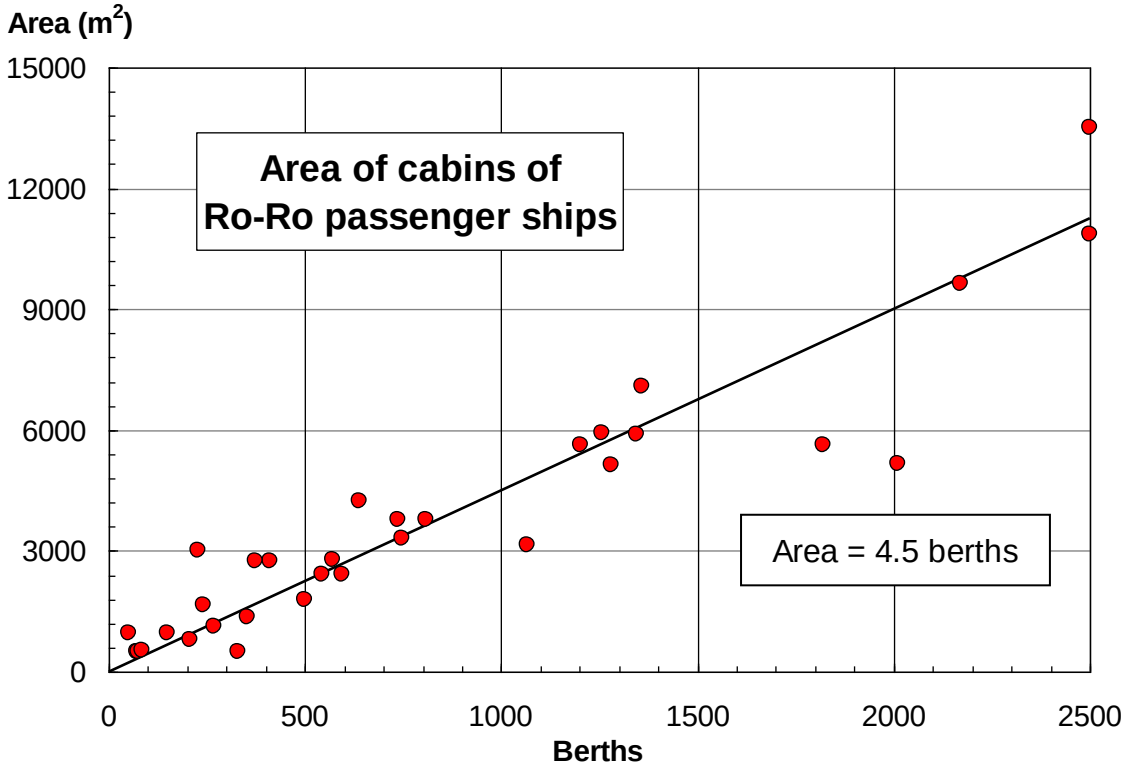

Fig. B4 Area of passenger cabins of Ro-Ro passenger ships (Hagemeister thesis work 2011)

Appendix C - Calculation example from CEN standard 16258

Example for combined passenger and freight transport: ferry lines

G.1 Description of the example

This example serves as an illustration of the impact of the two allocation methods specified in Annex B on one real ferry transport system.

The areas in the example are based on 100 % accessible area capacity according to valid general arrangement plan (GA-plan). The transport statistics used are one year real data i.e. this example presents an example of annual average allocation values. The values per entity used are the default values presented in Annex B, Table B1.

Table G.1 — Data for this example

	Annual activity data			Value per entity			
Entity	**Quantity**	**Mass (t)**	**Area (m²)**	**Mass (kg)**	**Area (m²)**	**Length (m)**	**Width (m)**
Pax deck area					7 550		
Vehicles deck area					5 770		
Passenger and luggage	478 500	47 850		100			
Passenger car	90 000	135 000	1 674 000	1 500	18,6	6	3,1
Bus	1 000	15 000	37 200	15 000	37,2	12	3,1
Caravan (small)	500	500	4 650	1 000	9,3	3	3,1
Caravan (medium)	500	1 000	9 300	2 000	18,6	6	3,1
Caravan (large)	500	1 250	15 500	2 500	31,0	10	3,1
Mobile home	-	-	-	3 500	24,8	8	3,1
Motorcycle	1 000	200	4 650	200	4,7	1,5	3,1
Unaccompanied trailer							
Empty trailer				8 000	43,4	14	3,1
Average load per trailer				19 000			
Total	4 000	108 000	173 600	27 000	43,4	14	3,1
Accompanied trailer							
Empty trailer				16 000	52,7	17	3,1
Average load per trailer				19 000			
Total	34 000	1 190 000	1 791 800	35 000	52,7	17	3,1

G.2 Results and comparison of the two allocation methods

In the mass allocation method, the weight of vehicles (including their loads for freight) and weight of passengers are based on annual activity data and values per entity presented in Table G.1. Table G.2 gives the corresponding results.

Table G.2 — Results with use of Mass allocation method

Mass allocation method	mass	%
Freight	1 298 000	87 %
Passengers	200 800	13 %
Total	1 498 800	100 %

In the area allocation method the relation between areas used by freight and passenger serves as the allocation ratio. Whole passenger deck area is allocated to passengers. Vehicle deck area is allocated according to the ratio between freight vehicles and passenger vehicles according to activity data and values per entity presented in Table G1. Table G.3 gives the corresponding results.

Table G.3 — Results with use of Area allocation method

Area allocation method	area	%
Freight	3 056	23 %
Passengers	10 264	77 %
Total	13 320	100 %

In conclusion, by using one allocation method or the other for the same combined passenger and cargo ferry, the distribution of energy consumption and GHG emissions gives completely different results. Hence, if the emission and energy data includes ferry vessel operation and the receiver of the data wishes to compare results, particular attention should be paid to the consistency in allocation methodology. As stated in Annex B.1, the ferry allocation method shall be consistent over time and per ferry line unless the ship is converted or allocated to a different line. Information about the allocation method used for a particular transport service will be available to the receiver of the data, and can be found in the supporting information which accompanies the declaration of results (see 10.3.2).

Appendix D - Calculation examples with CEN Standard 16258 based on SHIP-DESMO

Example No. 1 with 100 % trucks and 650 passengers – original area allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	65.0
Actual number of passengers	persons	650
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	5177
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	65

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4632
Actual deadweight	t	6770
Deadweight utilization	%	95
Rolling cargo (on trucks, trailers and mafis) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	650
Weight of passengers, busses and passenger cars	t	65
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	5177
Rolling cargo related area	m^2	9685
Passenger area allocation ratio	-	**0.35**
Cargo area allocation ratio	-	**0.65**
Ship speed	knots	22.6

Example No. 2 with 100 % trucks and only one (1) passenger – original area allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	0.1
Actual number of passengers	persons	1
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	5177
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	0

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4567
Actual deadweight	t	6705
Deadweight utilization	%	94
Rolling cargo (on trucks, trailers and mafis) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	1
Weight of passengers, busses and passenger cars	t	0
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	5177
Rolling cargo related area	m^2	9685
Passenger area allocation ratio	-	**0.35**
Cargo area allocation ratio	-	**0.65**
Ship speed	knots	22.6

Example No. 3 with 100 % trucks and NO passengers – original area allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	0.0
Actual number of passengers	persons	0
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	5177
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	0

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4567
Actual deadweight	t	6705
Deadweight utilization	%	94
Rolling cargo (on trucks, trailers and mafis) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	0
Weight of passengers, busses and passenger cars	t	0
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	5177
Rolling cargo related area	m^2	9685
Passenger area allocation ratio	-	**0.35**
Cargo area allocation ratio	-	**0.65**
Ship speed	knots	22.6

Example No. 4 with 100 % trucks and 650 passengers – Corrected area allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	65.0
Actual number of passengers	persons	650
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	3365
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	65

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4632
Actual deadweight	t	6770
Deadweight utilization	%	95
Rolling cargo (on trucks, trailers and mafis) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	650
Weight of passengers, busses and passenger cars	t	65
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	3365
Rolling cargo related area	m^2	9685
Passenger area allocation ratio	-	**0.26**
Cargo area allocation ratio	-	**0.74**
Ship speed	knots	22.6

Example No. 5 with 100 % trucks and one (1) passenger – Corrected area allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	0.1
Actual number of passengers	persons	1
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	5
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	0

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4567
Actual deadweight	t	6705
Deadweight utilization	%	94
Rolling cargo (on trucks, trailers and mafis) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	1
Weight of passengers, busses and passenger cars	t	0
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	5
Rolling cargo related area	m^2	9685
Passenger area allocation ratio	-	**0.0005**
Cargo area allocation ratio	-	**0.9995**
Ship speed	knots	22.6

Example No. 6 with 100 % trucks and NO passengers – Corrected area allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	0.0
Actual number of passengers	persons	0
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	0
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	0

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4567
Actual deadweight	t	6705
Deadweight utilization	%	94
Rolling cargo (on trucks, trailers and mafis) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	0
Weight of passengers, busses and passenger cars	t	0
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	0
Rolling cargo related area	m^2	9685
Passenger area allocation ratio	-	**0.00**
Cargo area allocation ratio	-	**1.00**
Ship speed	knots	22.6

Example No. 7 with 100 % trucks and 650 passengers – Mass allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	65.0
Actual number of passengers	persons	650
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	3365
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	65

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4632
Actual deadweight	t	6770
Deadweight utilization	%	95
Rolling cargo (on trucks, and trailers) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	650
Weight of passengers, busses and passenger cars	t	65
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	3365
Rolling cargo related area	m^2	9685
Passenger mass allocation ratio	-	**0.01**
Cargo mass allocation ratio	-	**0.99**
Ship speed	knots	22.6

Example No. 8 with 100 % trucks and one (1) passenger – Mass allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	0.1
Actual number of passengers	persons	1
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	5
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	0

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4567
Actual deadweight	t	6705
Deadweight utilization	%	94
Rolling cargo (on trucks, and trailers) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	1
Weight of passengers, busses and passenger cars	t	0
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	5
Rolling cargo related area	m^2	9685
Passenger mass allocation ratio	-	**0.00002**
Cargo mass allocation ratio	-	**0.99998**
Ship speed	knots	22.6

Example No. 9 with 100 % trucks and NO passengers – Mass allocation

CEN STANDARD 16258 - CALCULATION OF KEY FIGURES		
Lanemeters used for **rolling cargo** in pct. of total lanemeters	%	100
Lanemeters used for **busses** in pct. of total lanemeters	%	0
Lanemeters used for **cars & caravans** in pct. of total lanemeters	%	0
Occupied lanemeters in total	m	2362
Fuel oil, ballast and fresh water and other consumerables	t	2108
Actual cargo weight per lanemeter	t/m	1.93
Cars	cars	0
Passenger utilization in pct. of maximum number of passengers	%	0.0
Actual number of passengers	persons	0
Area per passenger car	m^2	15
Area per lanemeter (for trucks and personal cars)	m^2	4.1
Area per berth	m^2	4.5
Passenger comfort class (1 = low, 2 = average or 3 = high)	-	2
Area per passenger (cafeteria, restaurants, halls, toilets etc.)	m^2	2.4
Area accupied by passenger cars	m^2	0
Area accupied by busses	m^2	0
Passenger public area (cafeteria, restaurants, gangways etc.)	m^2	2400
Total cabin area	m^2	2777
Actual passenger related area	m^2	0
Rolling cargo related area	m^2	9685
Weight of actual rolling cargo (trucks, trailers, mafis etc.)	t	4567
Weight of passengers, busses and passenger cars	t	0

		Default
Capacity utilization of lanes	%	100
Utilized lanemeters for rolling cargo (trucks and trailers)	m	2362
Actual payload	t	4567
Actual deadweight	t	6705
Deadweight utilization	%	94
Rolling cargo (on trucks, and trailers) per lanemeter	t/m	1.93
Actual number of cars	cars	0
Actual number of passengers	persons	0
Weight of passengers, busses and passenger cars	t	0
Total weight of rolling cargo (trucks, trailers, mafis etc.)	t	4567
Total passenger related area	m^2	0
Rolling cargo related area	m^2	9685
Passenger mass allocation ratio	-	**0.00000**
Cargo mass allocation ratio	-	**1.00000**
Ship speed	knots	22.6